

CFFDRS and research applications: slides for informal discussion

Mike Wotton

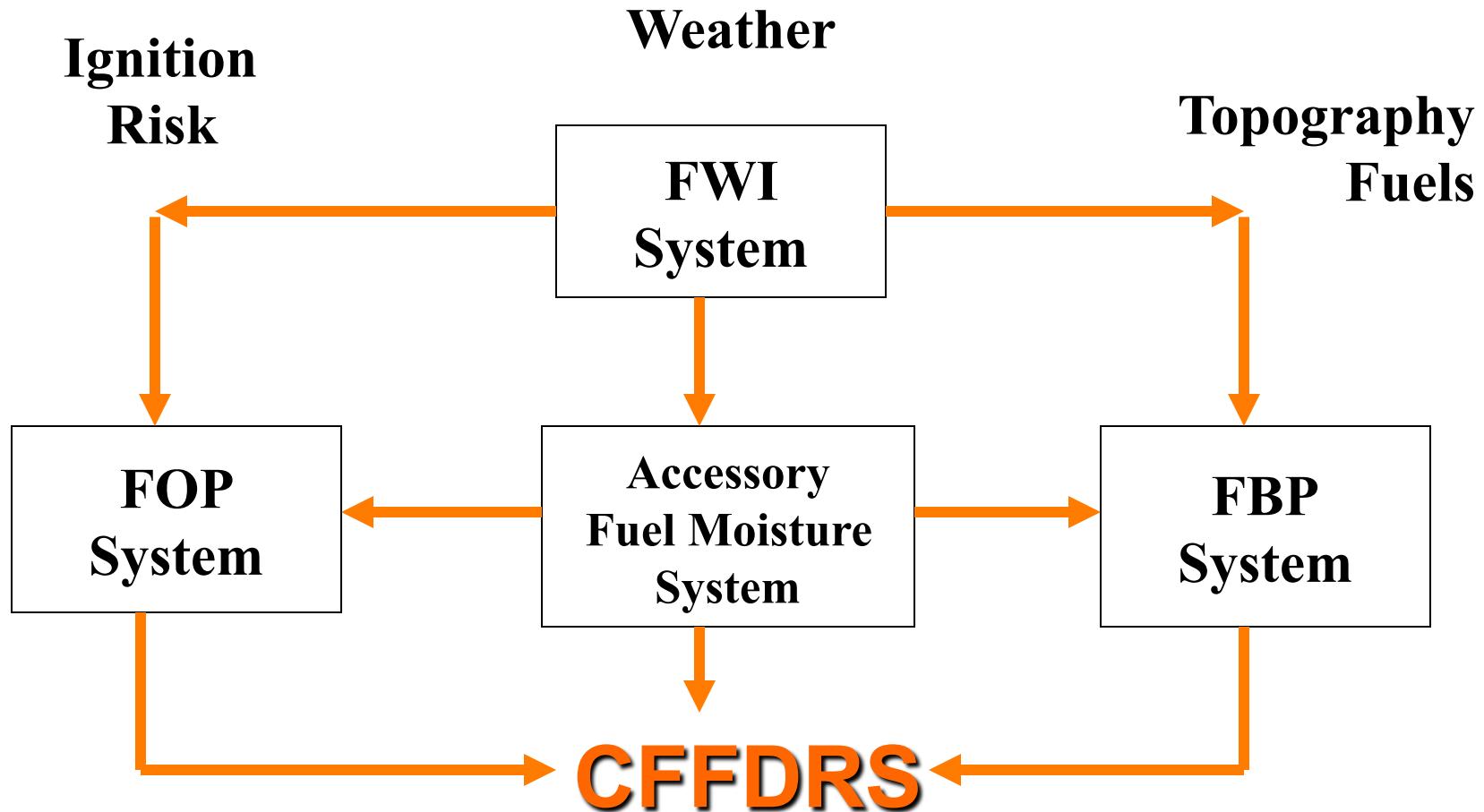
Canadian Forest Service

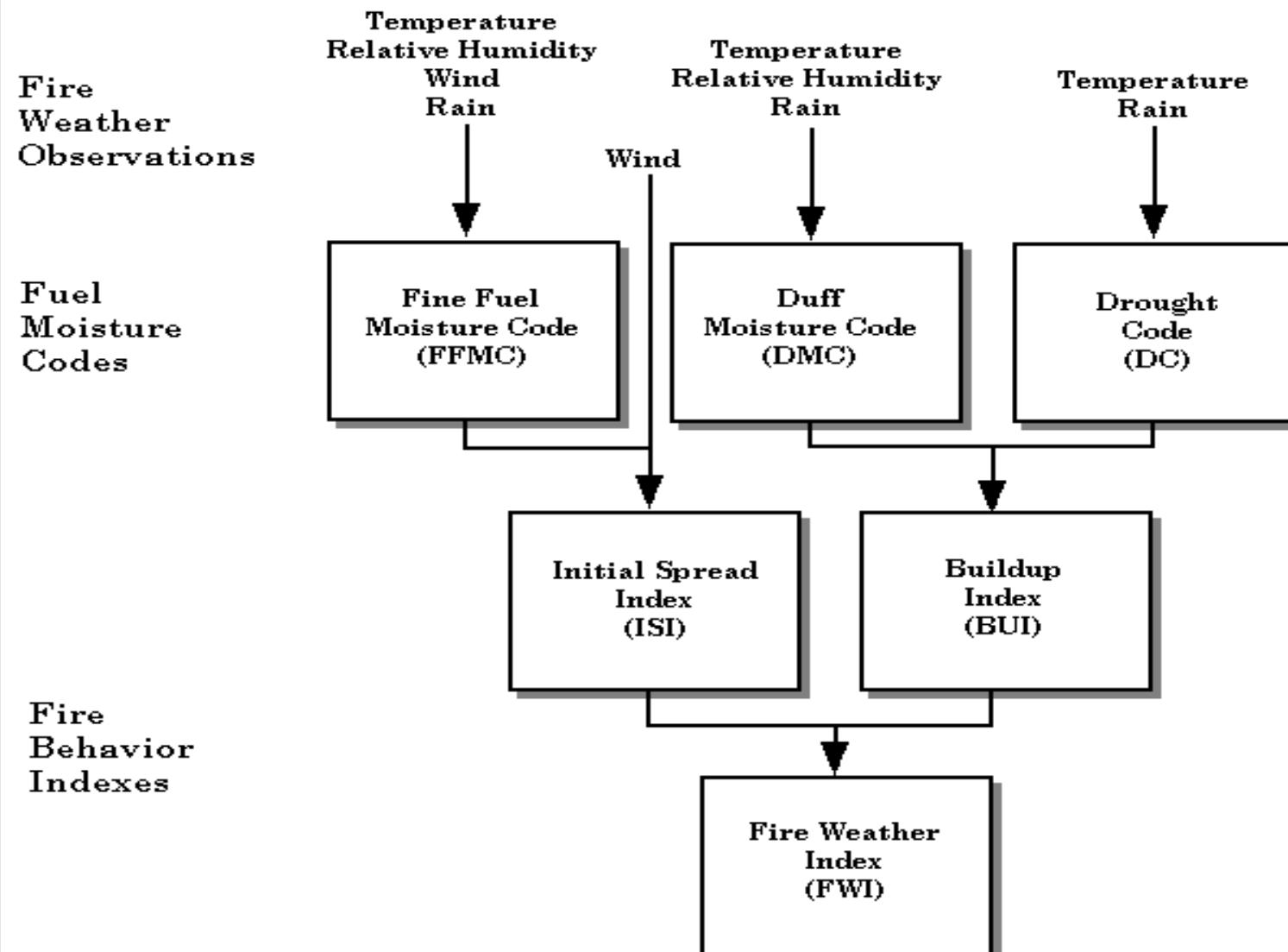
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The Canadian Fire Danger Rating System





The FWI System: Fuel Moisture Codes

1. These moisture models are in essence bookkeeping systems that track day to day changes in moisture. At their core, each model relies on a general exponential model of moisture exchange

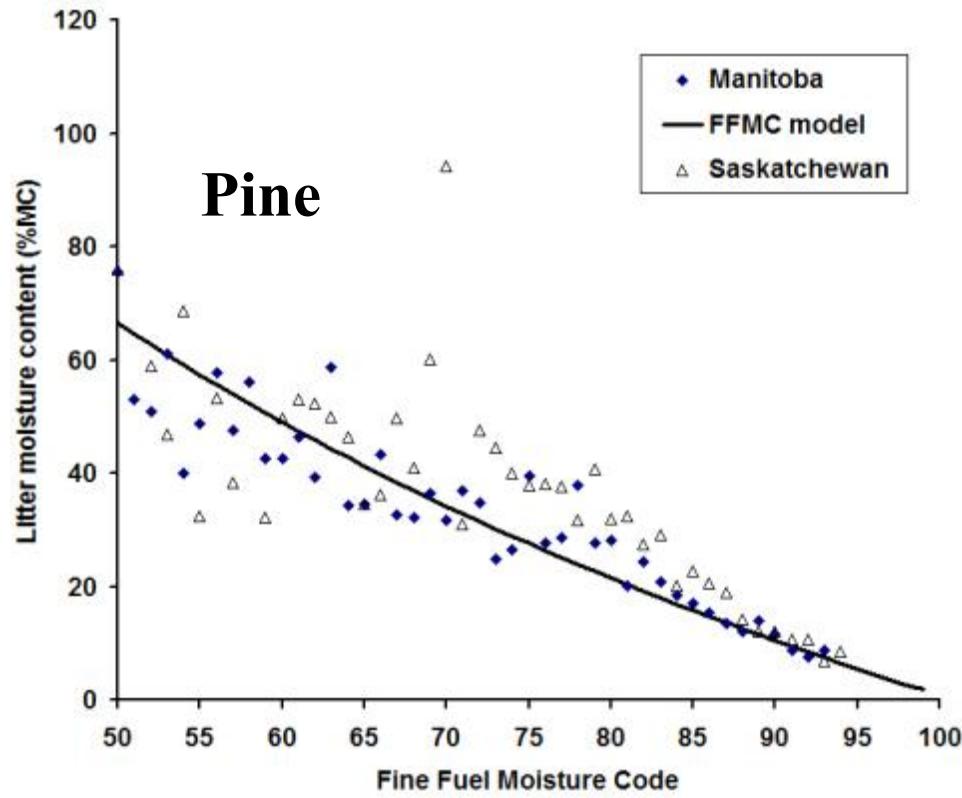
$$\frac{m_t - m_e}{m_o - m_e} = e^{-t/\tau}$$

2. And a function that accounts for rain

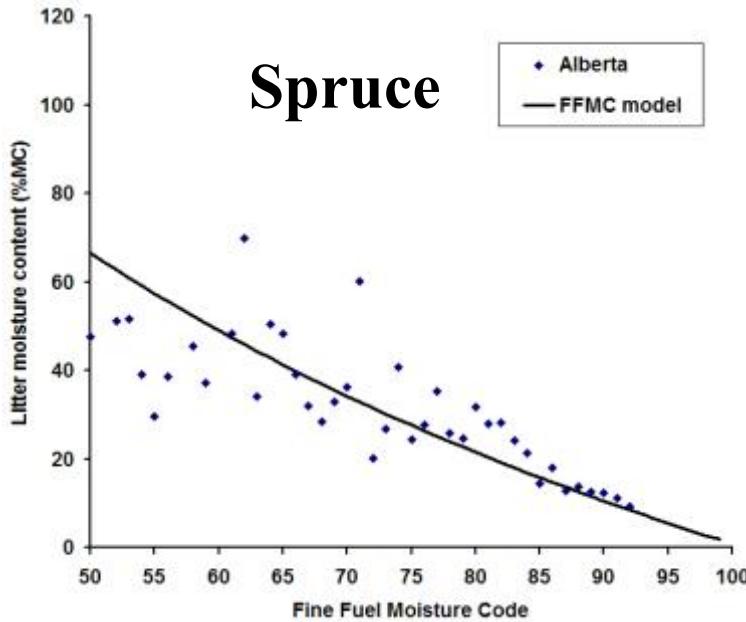
- Each day (in the absence of rain) they move toward an equilibrium value (m_e), with a characteristic fuel layer time lag of τ

The Fine Fuel Moisture Code (FFMC)

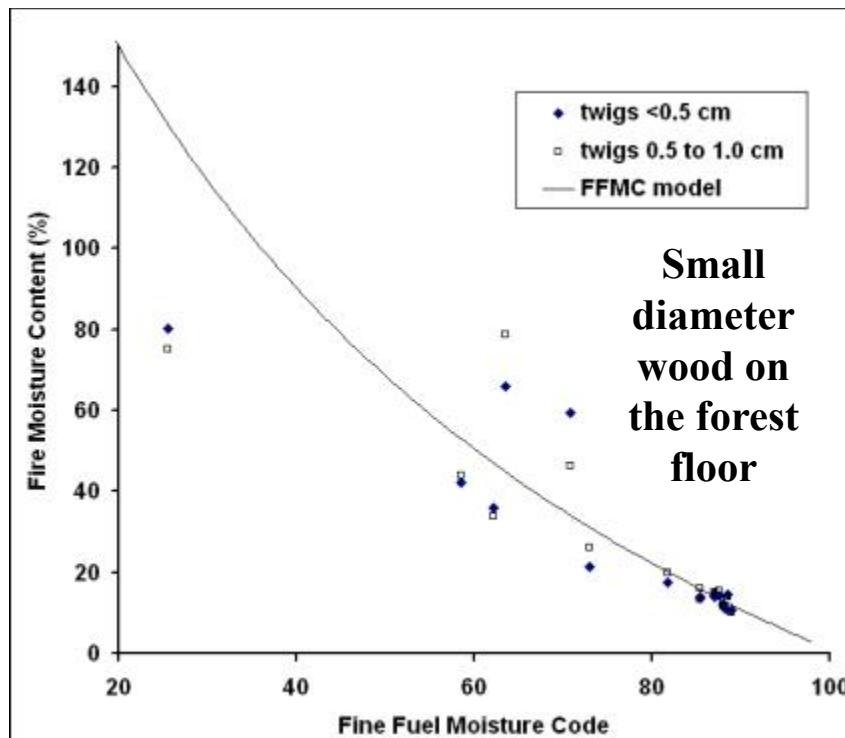
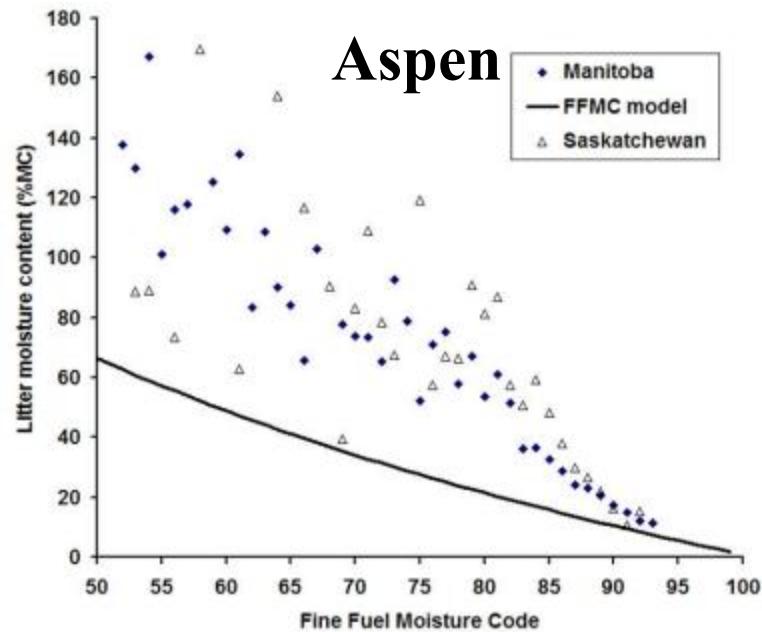
- The FFMC was developed from moisture sampling in closed canopy jack pine and lodge pole pine stands.
- HOWEVER, it is used across the country as an indicator of fine fuel moisture in a wide variety of forest types

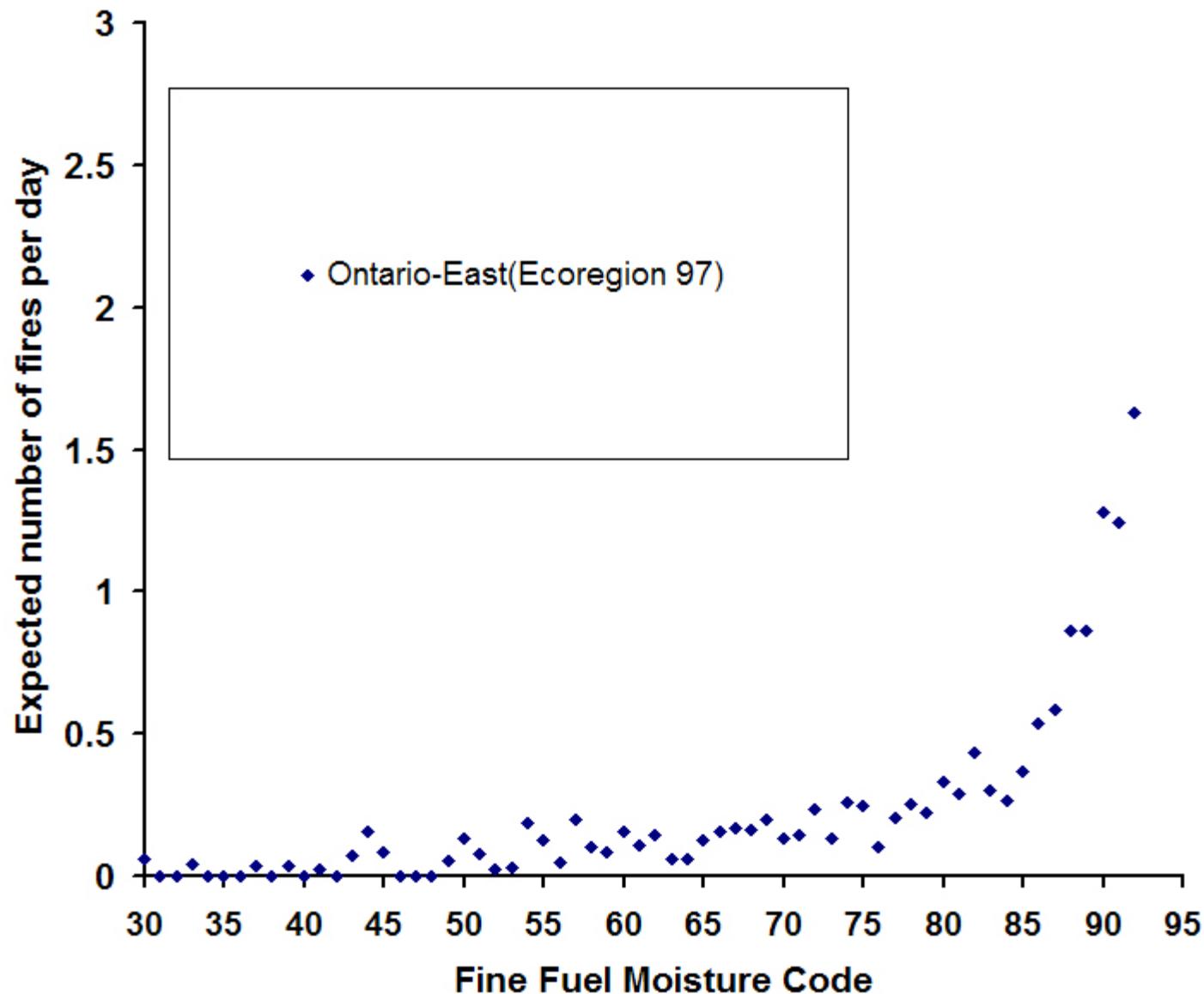


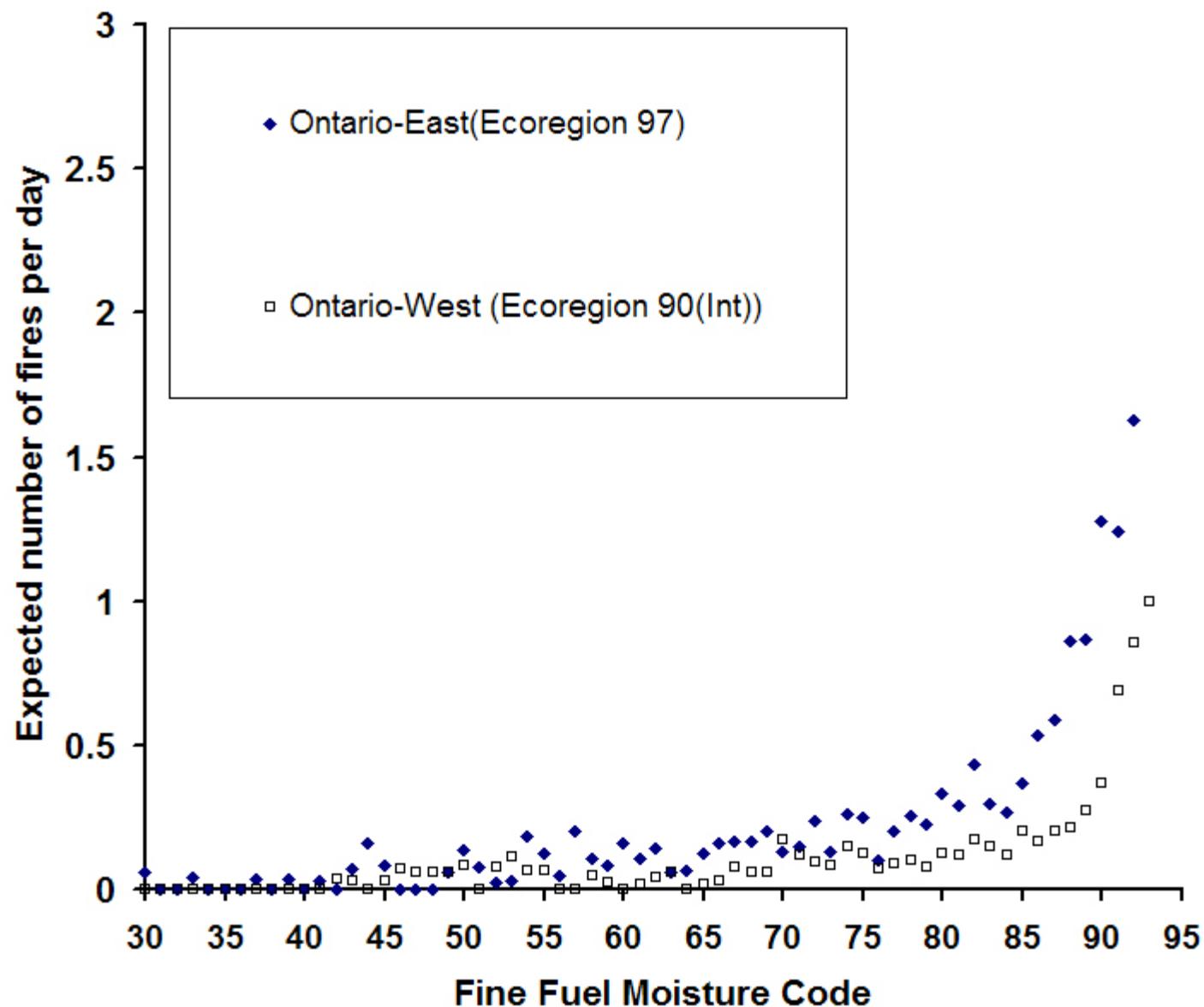
Spruce

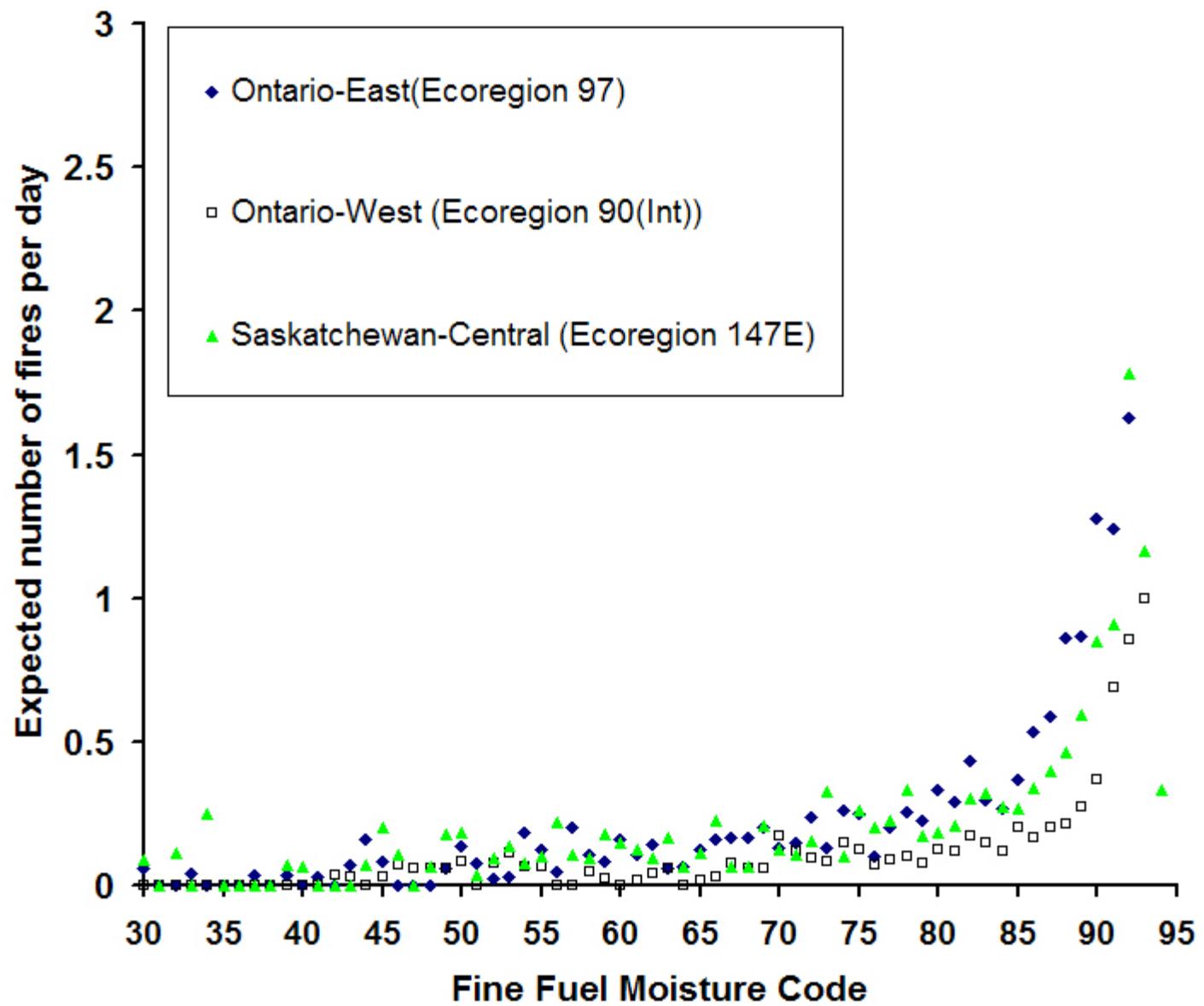


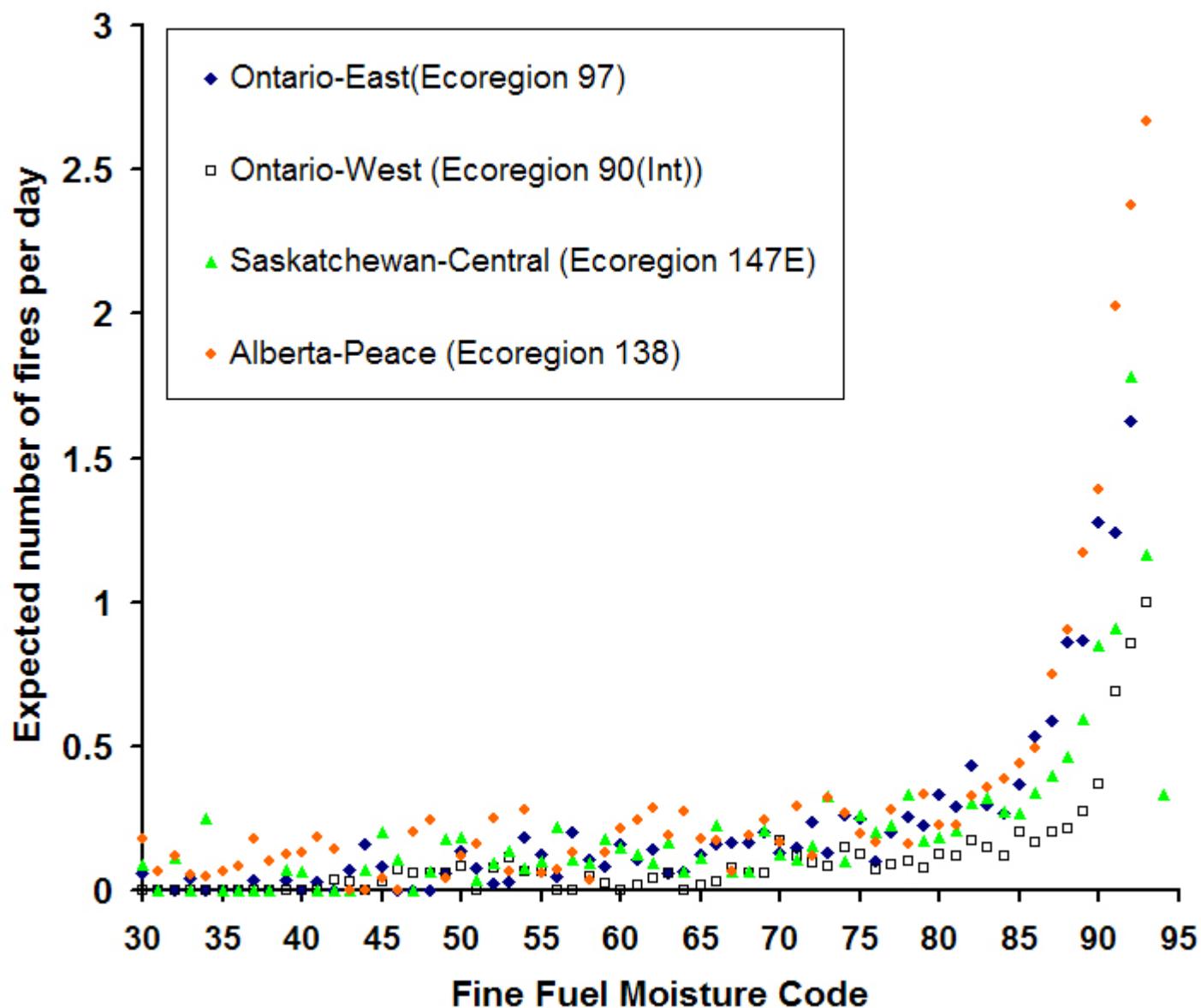
Aspen











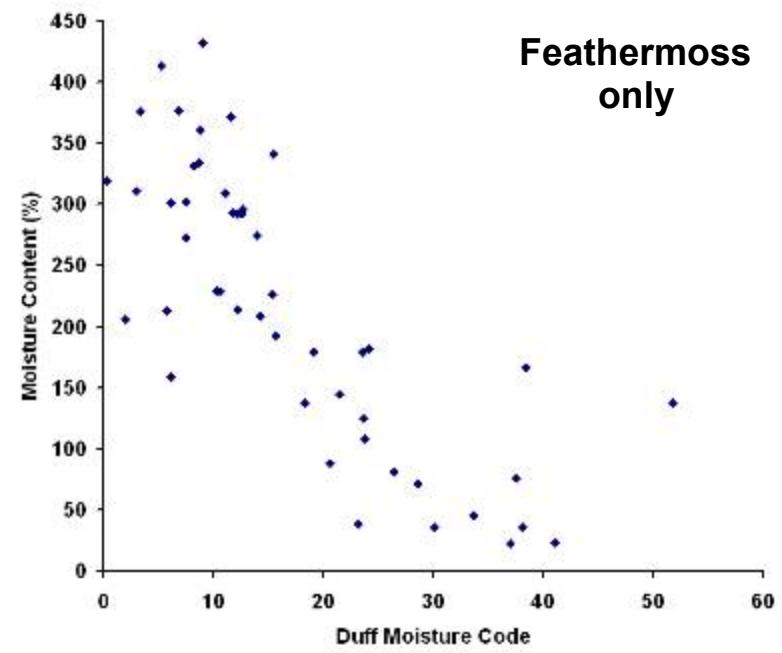
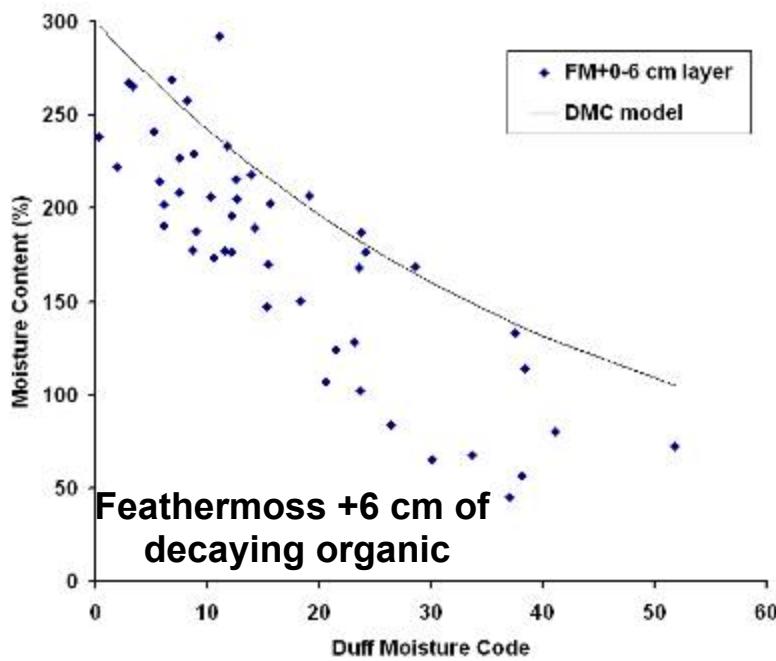
DMC and lightning fire ignition

- The duff moisture code is used across Canada as an excellent indicator of receptivity of the forest to lightning fire ignition

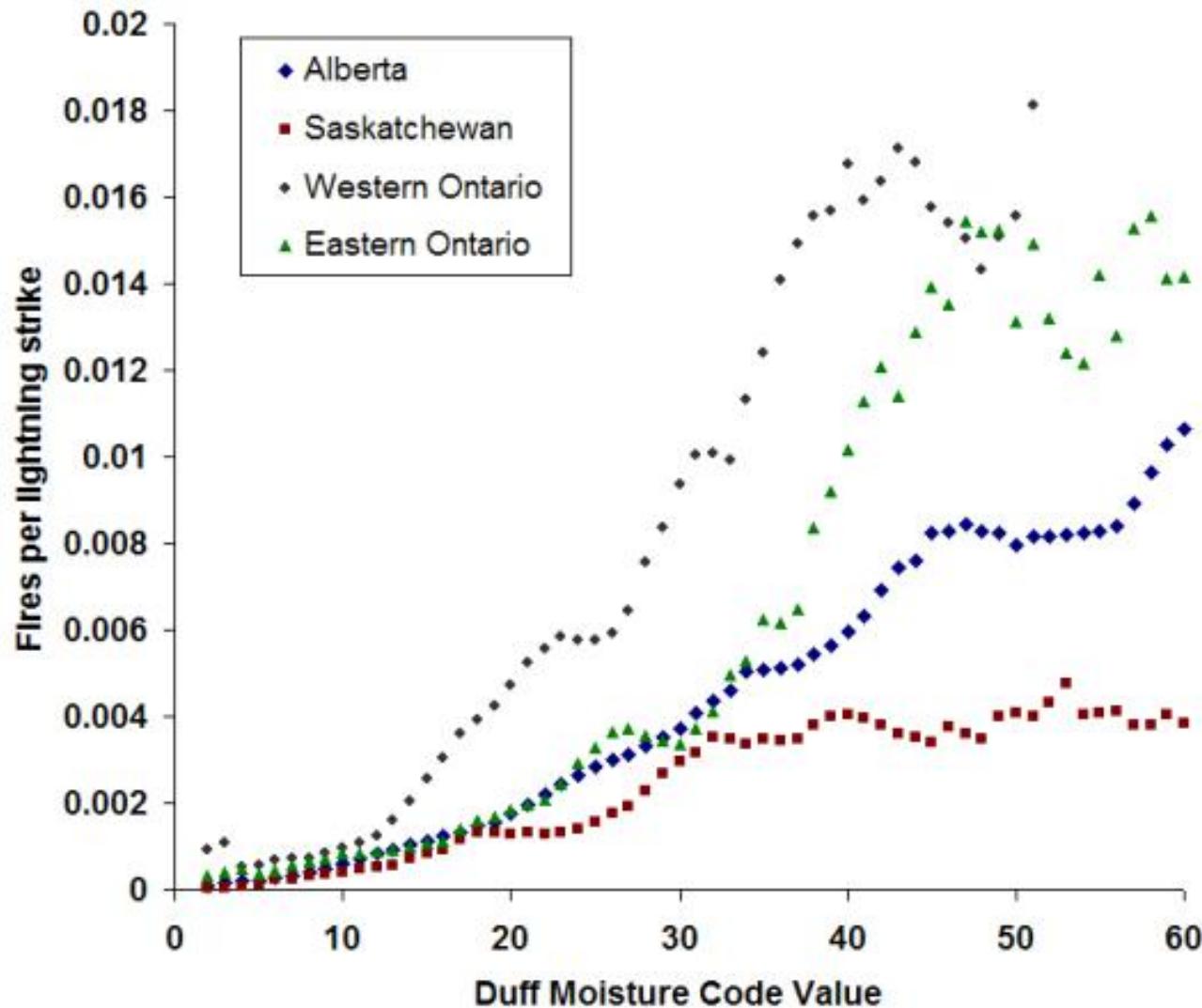


The Duff Moisture Code (DMC)

- The DMC was developed in a closed canopy jack pine stand in eastern Ontario
 - However it tracks moisture in other types of organic layer as well



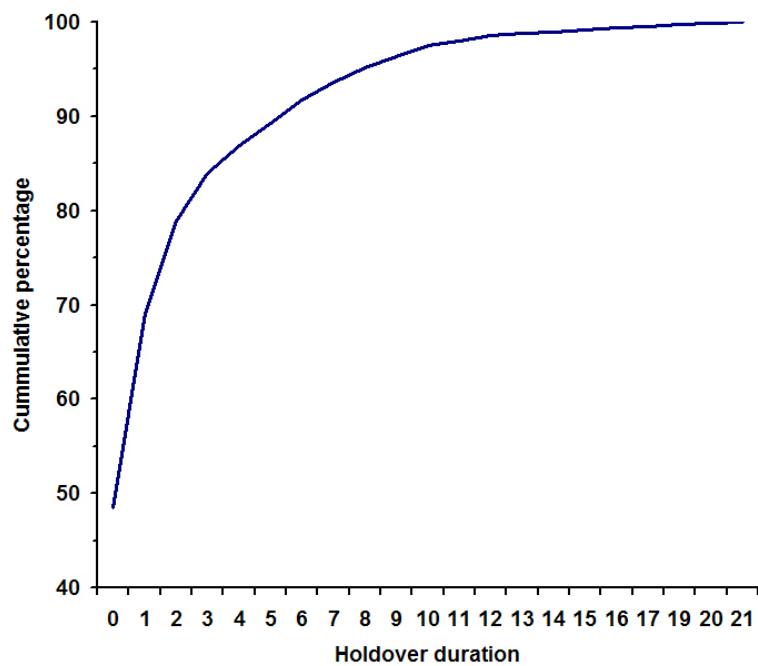
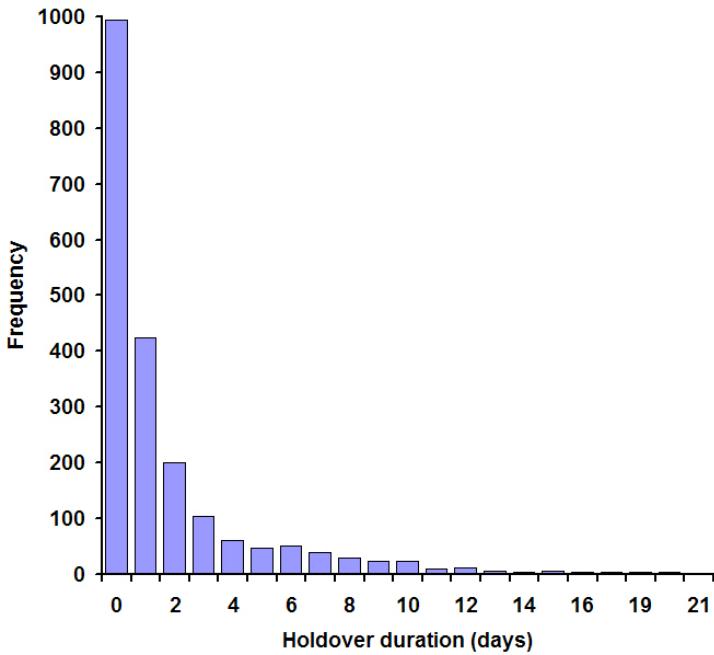
DMC and lightning fire ignition

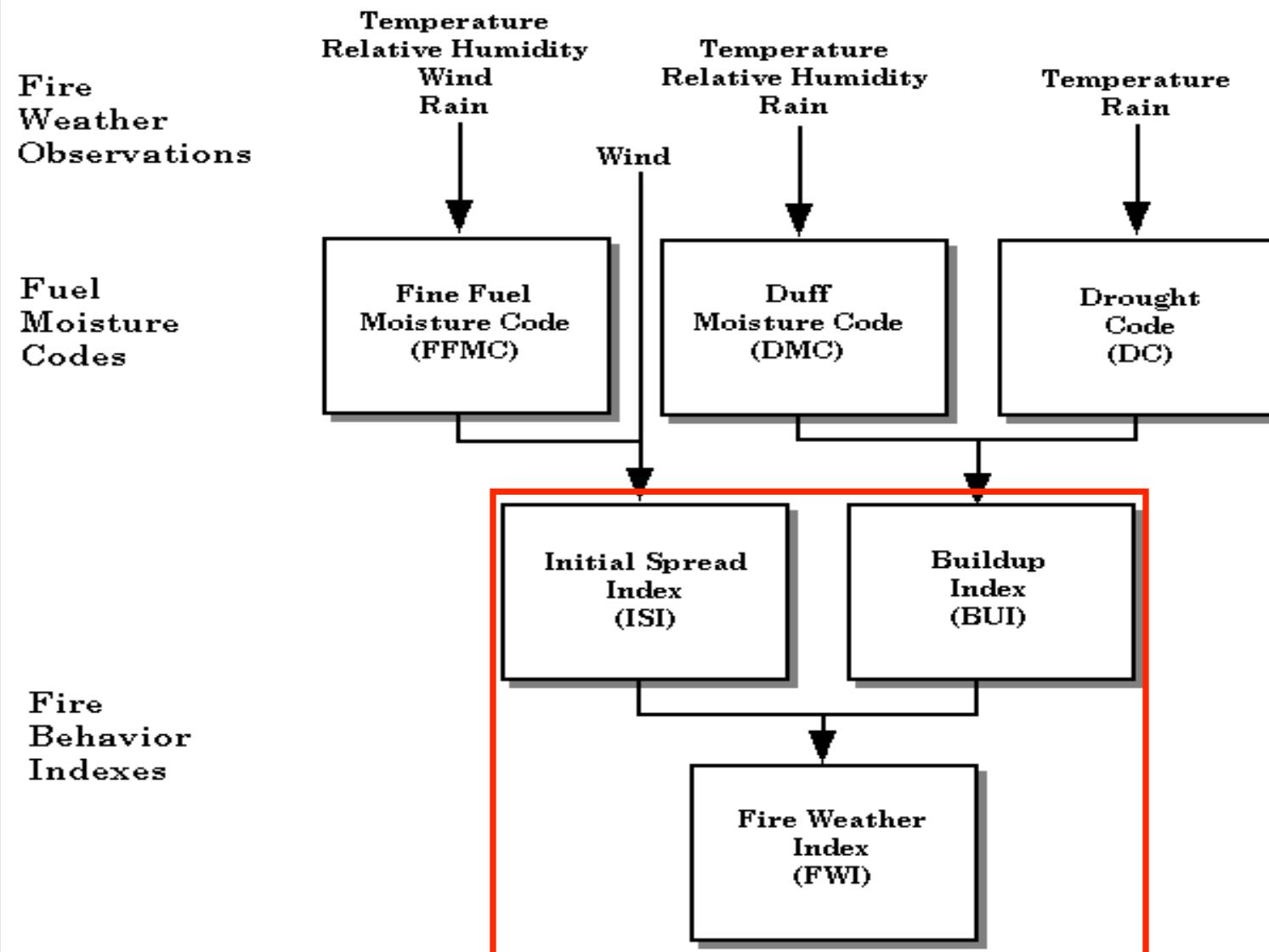


Lightning-caused fire



- Holdover
 - The period between ignition (from lightning) and arrival/detection





The FWI System : RELATIVE fire behavior potential indices

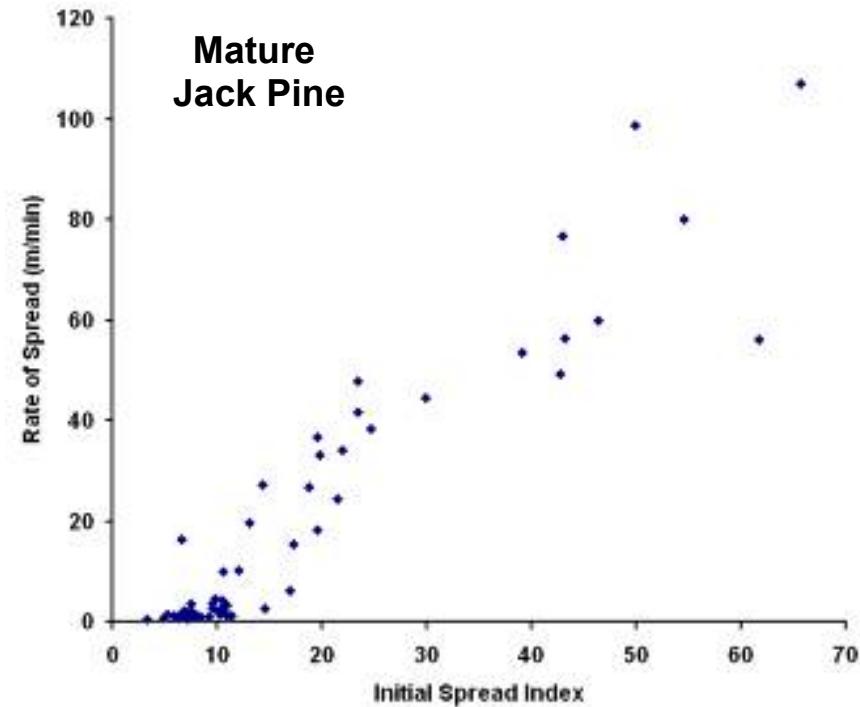
- The ISI, BUI and FWI are all relative indicators of different aspects of fire behaviour
- They follow Byram's classic fireline intensity formula:

$$I = H \frac{W}{R}$$

The Initial Spread Index (ISI)

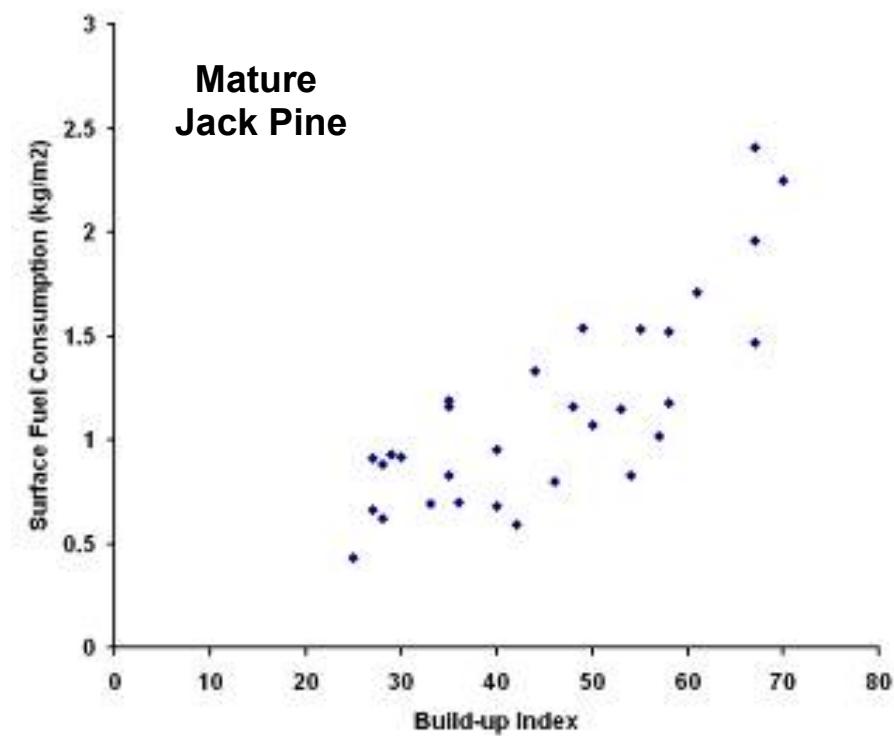
“R”

- The ISI is used as a general indicator of rate of spread potential in a region.
 - ISI is explicitly correlated with ROS for multiple forest types in the Fire Behaviour Prediction System



The Build-up Index (BUI) “W”

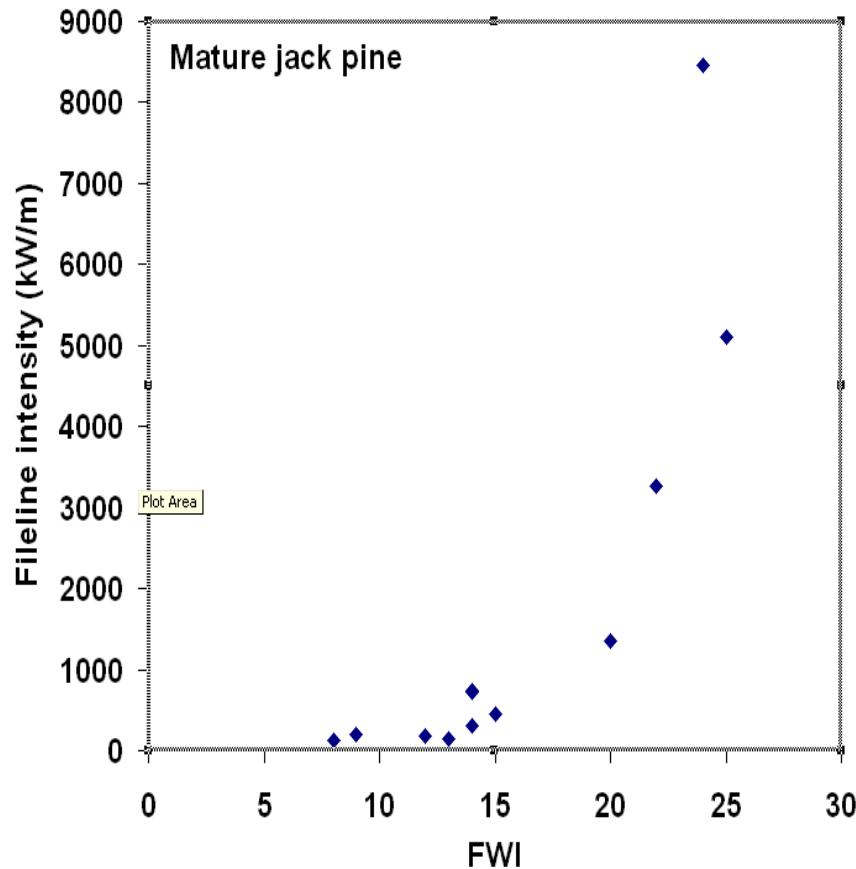
- The **BUI** is best used as a predictor of potential fuel consumption as it is a good indicator of an extended period of drying and resulting drier heavy fuels



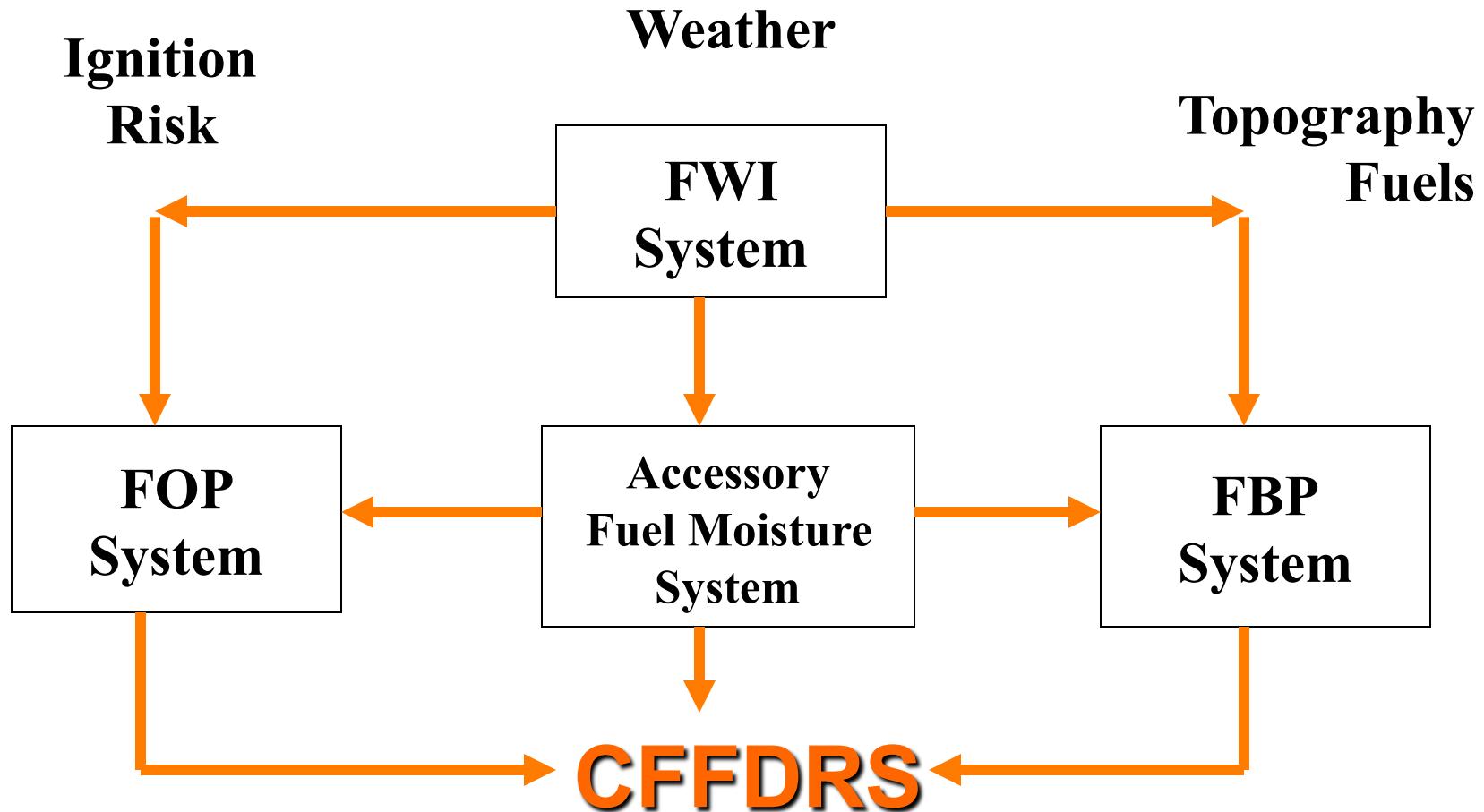
The Fire Weather Index (FWI)

“I”

- The FWI is a unitless value used as a general index of fire danger throughout the forested areas of Canada and indicates of the potential intensity of a spreading fire.



The Canadian Fire Danger Rating System

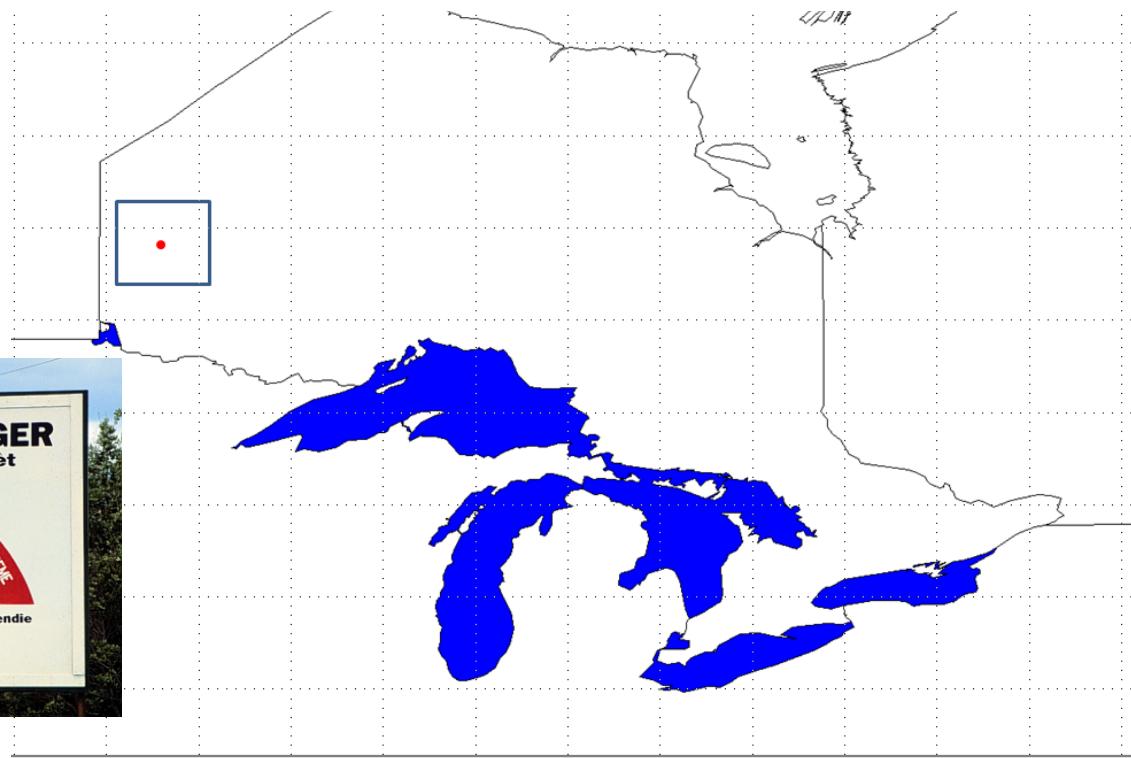


The FWI System: Regional analysis

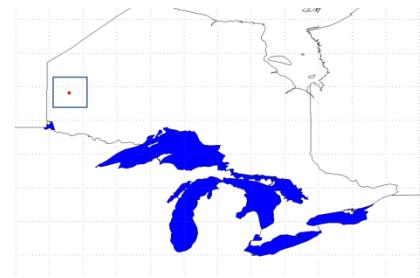
- Lets look at a summary of fire data and fires in an area ... around Red Lake, Ontario.

35 years of fires and weather

Fires from an ≈ 150 km by 150 km square



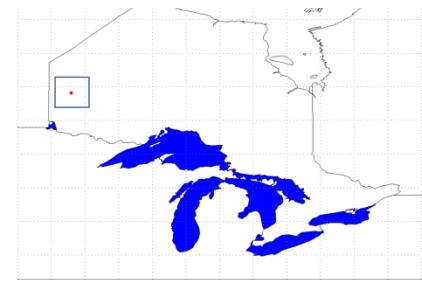
FWI and ALL fires



	PECENTAGE of days in fire season in category	Percentage of fires started in this category	Percentage of Area burned in this category*
LOW (0-3)	44 %	25 %	5 %
MODERATE (4-10)	29 %	21 %	4 %
HIGH (11-22)	23 %	38 %	25 %
EXTREME (≥23)	4 %	16 %	66 %

* Based on the conditions on the start day only.

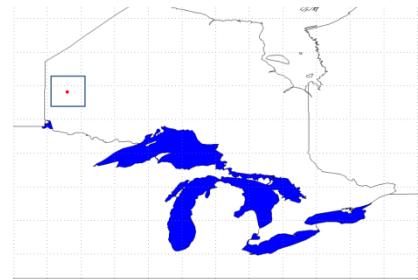
FFMC and HUMAN-caused fires



	PECENTAGE of days in fire season in category	Percentage of fires started in this category	Percentage of area burned in this category*
LOW (0-80)	43 %	13 %	0 %
MODERATE (81-86)	25 %	19 %	0 %
HIGH (87-90)	26 %	42 %	1 %
EXTREME (≥91)	7 %	25 %	99 %

* Based on the conditions on the start day only.

DMC and LIGHTNING-caused fires



	PECENTAGE of days in fire season in category	Percentage of fires started in this category	Percentage of area burned in this category*
LOW (0-15)	52 %	22 %	8 %
MODERATE (16-30)	30 %	31 %	19 %
HIGH (31-50)	14 %	34 %	25 %
EXTREME (≥50)	4 %	13 %	47 %

* Based on the conditions on the start day only.

Extended CFFDRS-driven products

- CanFIRE – Fuel consumption and effects
- CWFIS
- National fire occurrence (Ltg)
- Prometheus – fire growth
- Burn-P3 – Landscape burn probability
- PFAS – probability of fire growth
- Smoke plume/emissions transport

CanFIRE

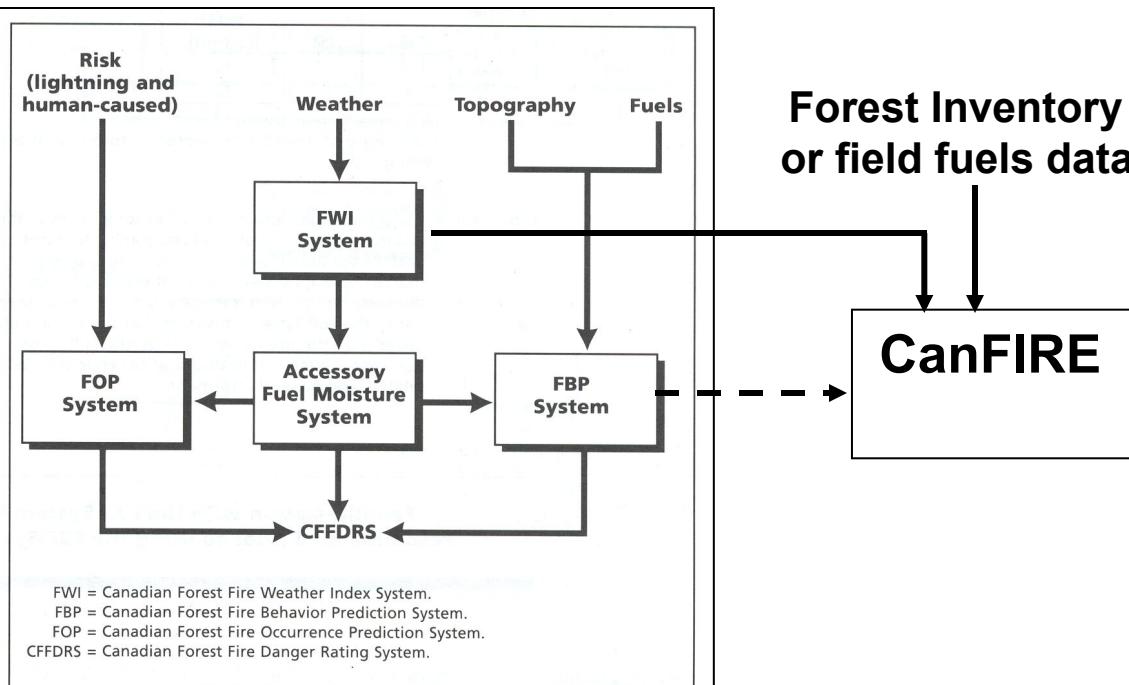


Figure 1. Structure of the Canadian Forest Fire Danger Rating System.

Fire behaviour:

- rate of spread
- fuel consumption
- fire intensity, type

Physical fire effects:

- depth of burn
- C emissions
- crown scorch ht

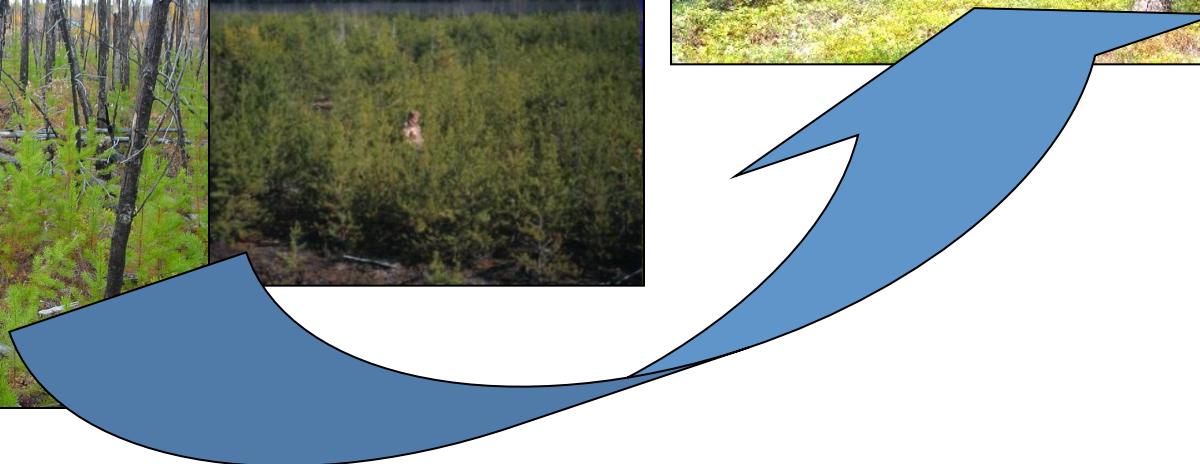
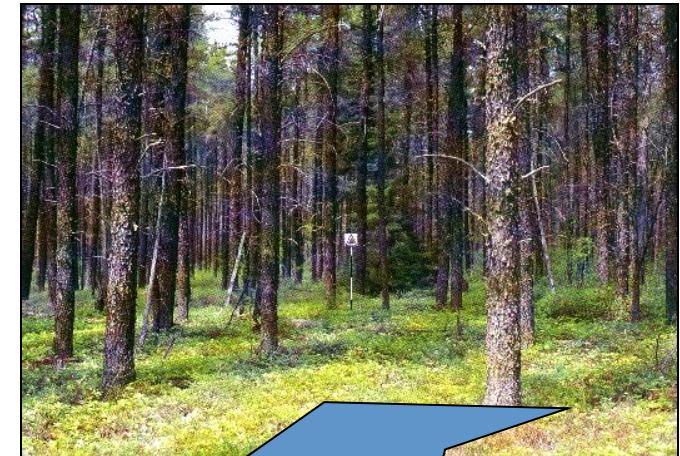
Ecological fire effects:

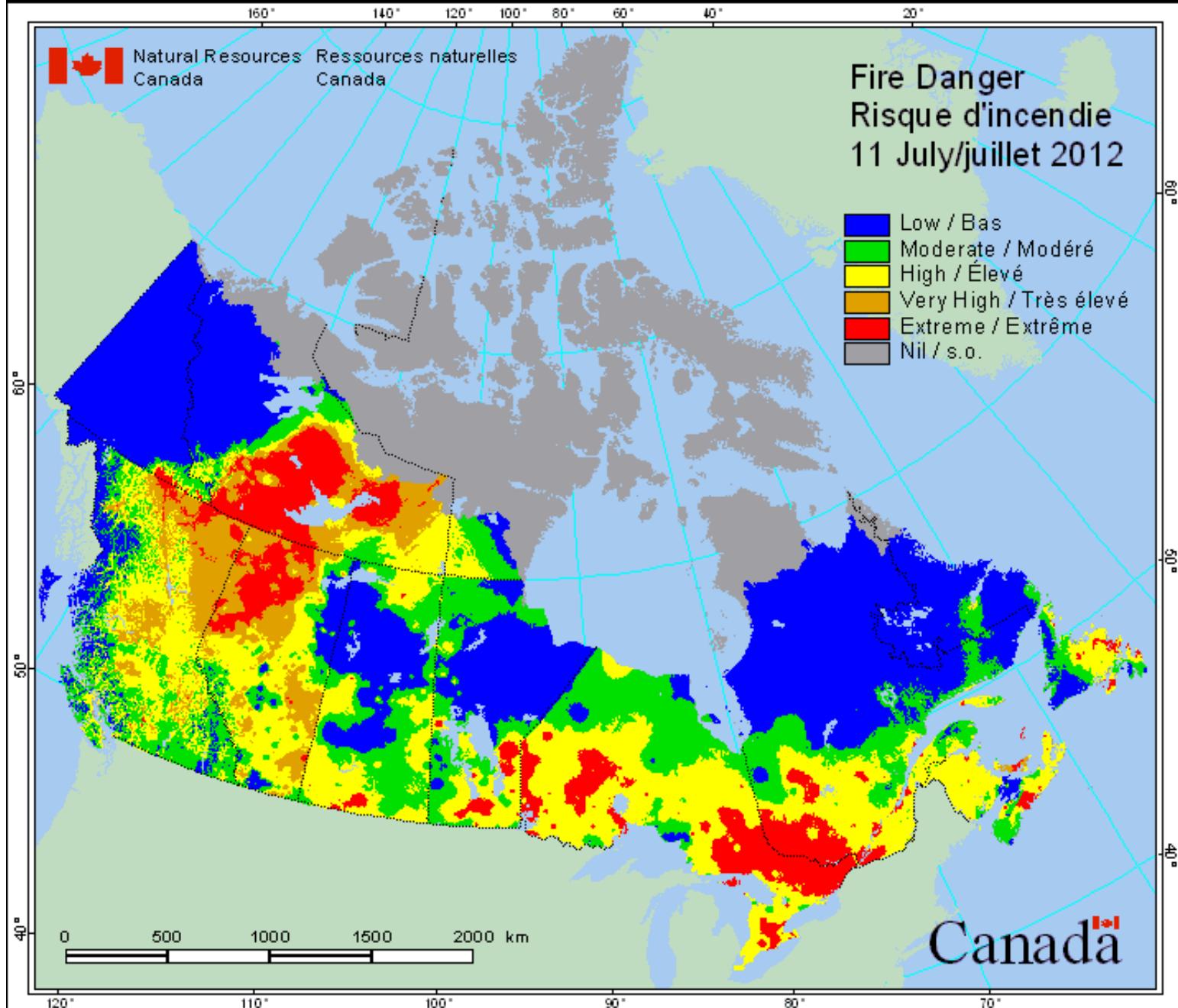
- tree mortality/survival
 - regeneration
 - postfire succession

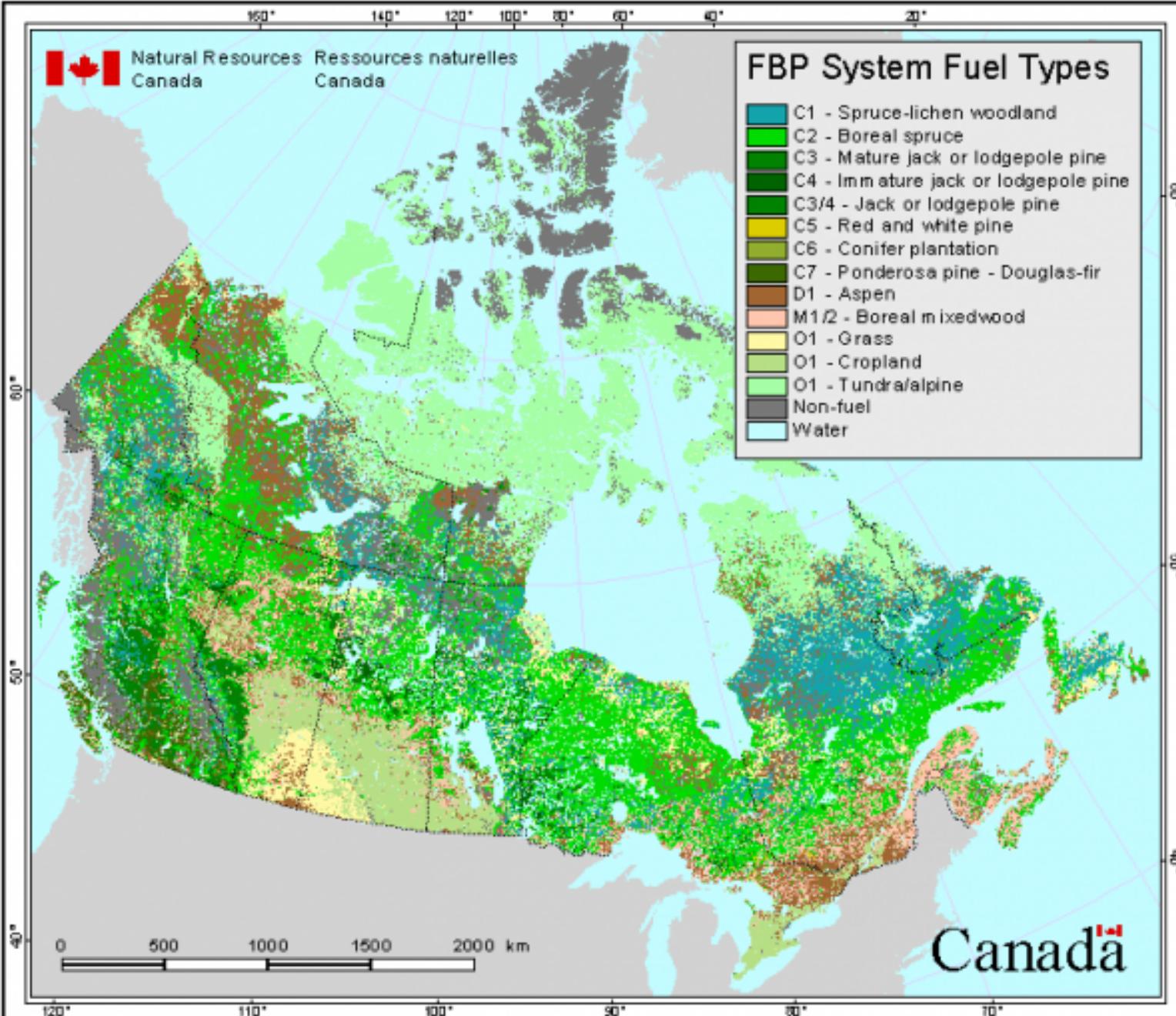
CanFIRE

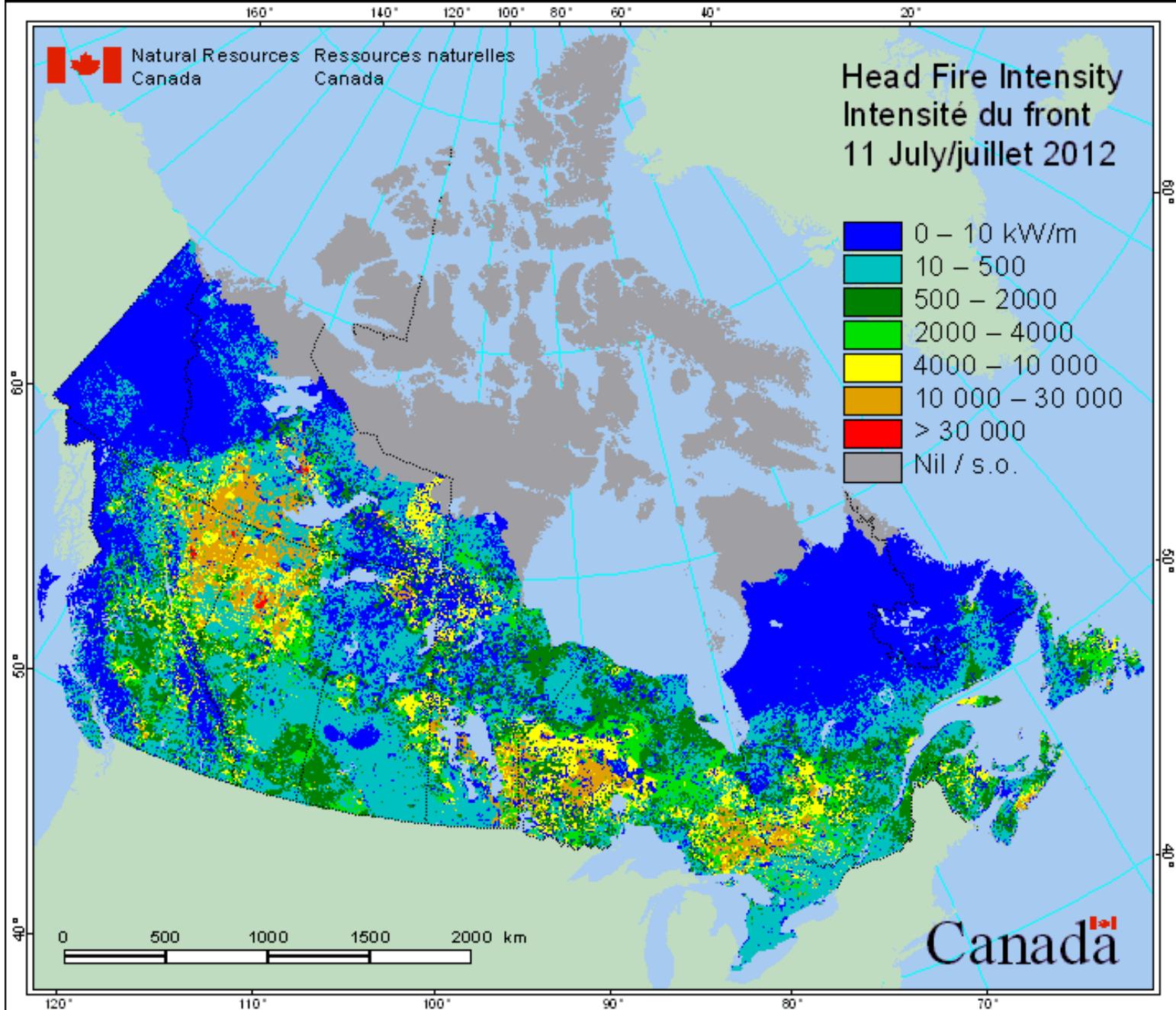
Dynamic Fuel Submodel

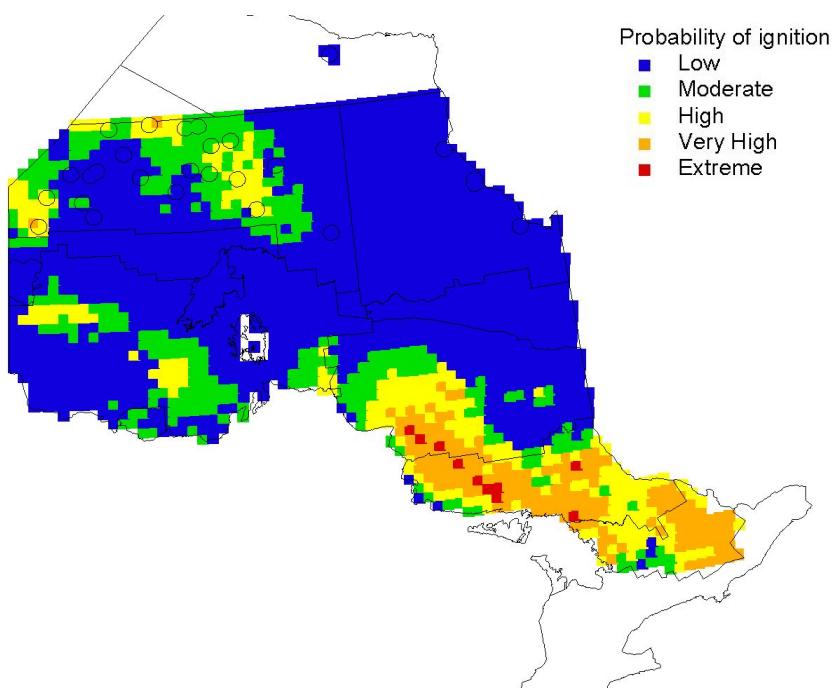
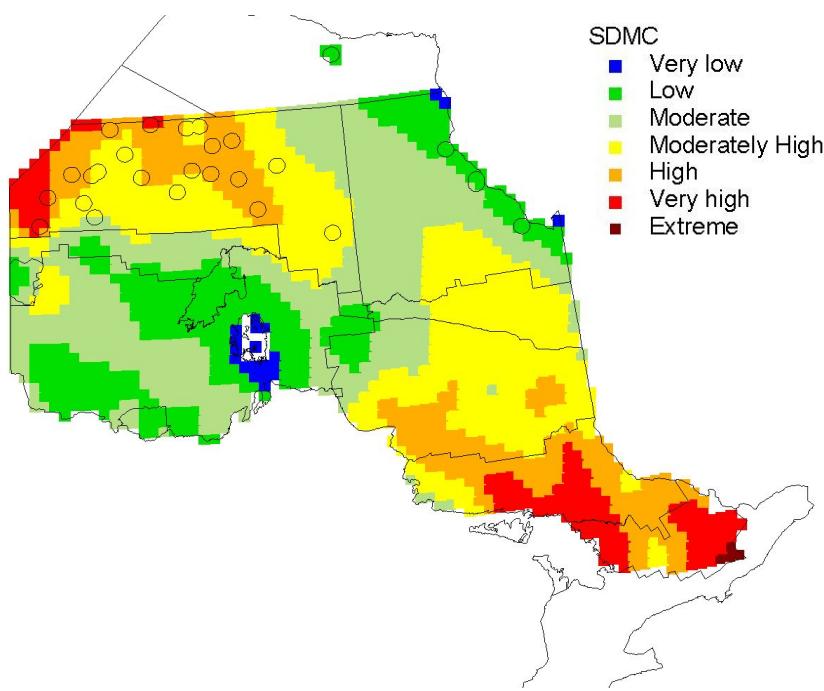
- variable fuel load in different stand components, changing over time
- link to forest inventory or field data



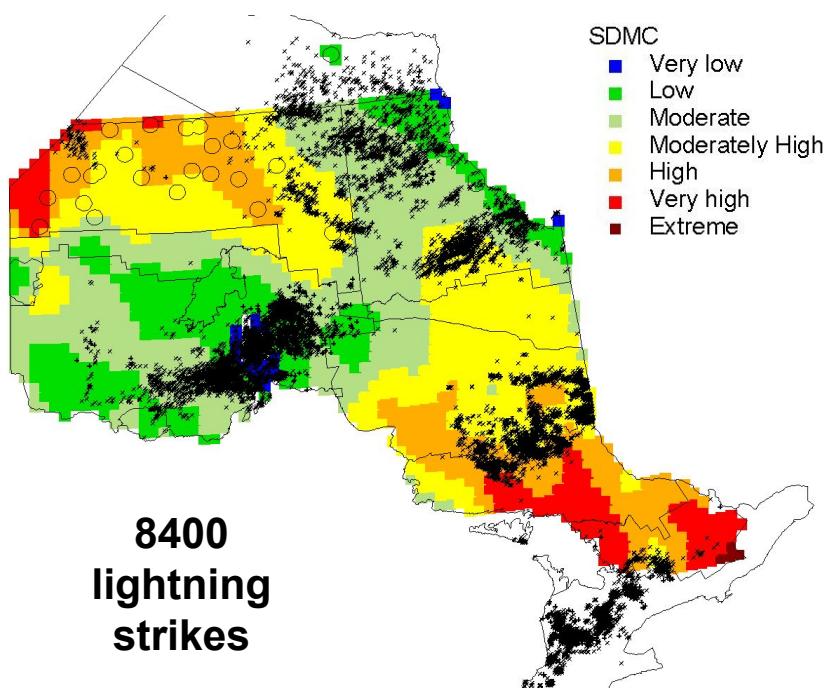




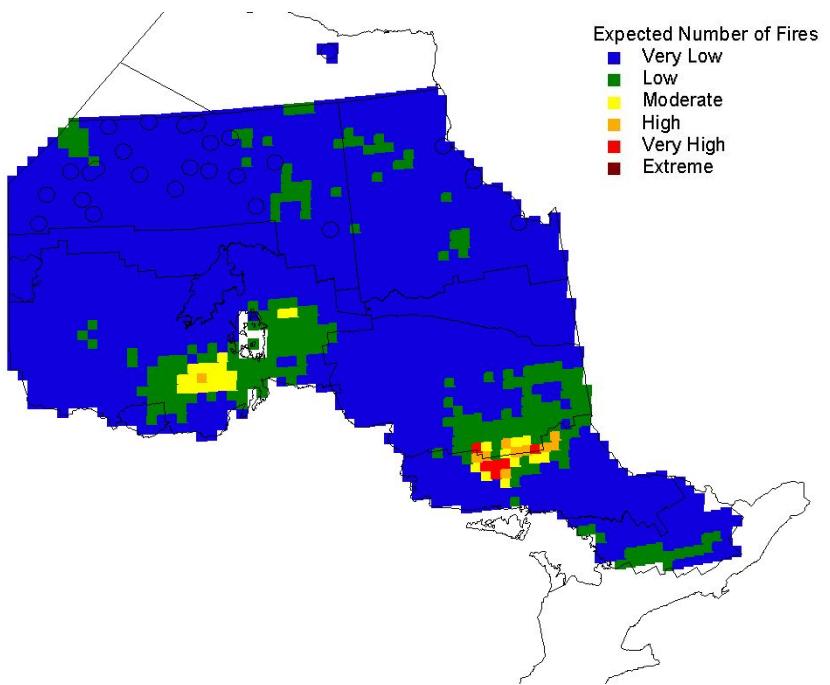
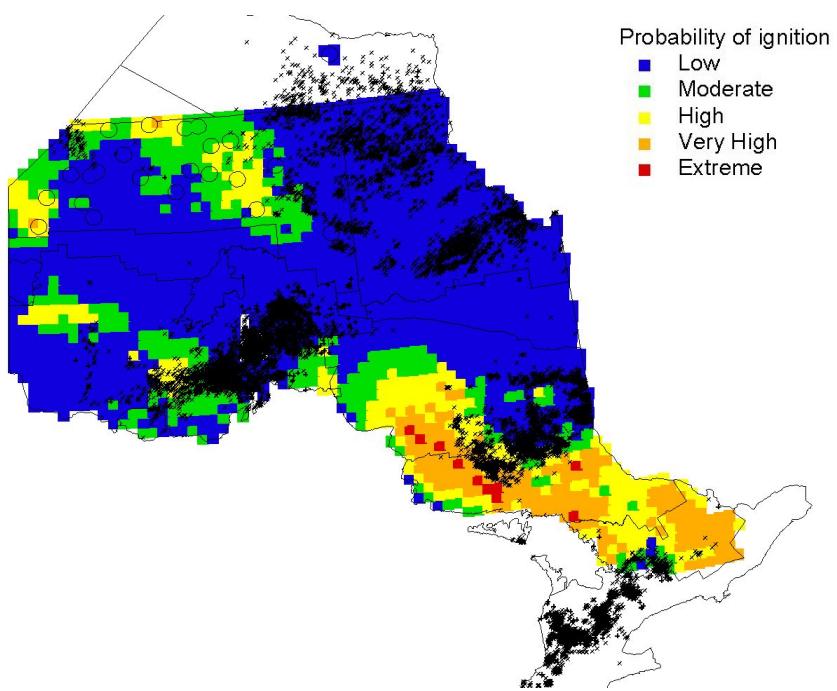


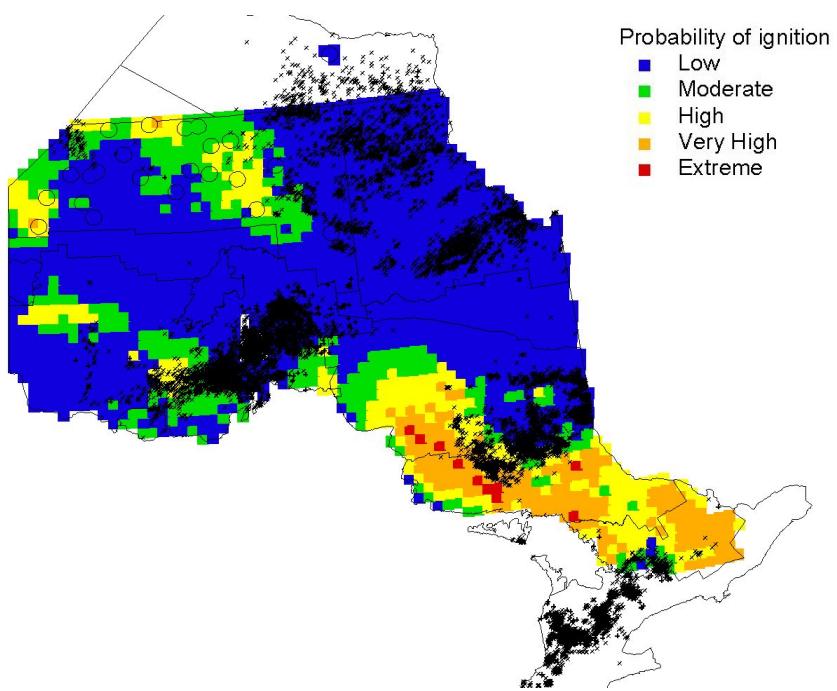
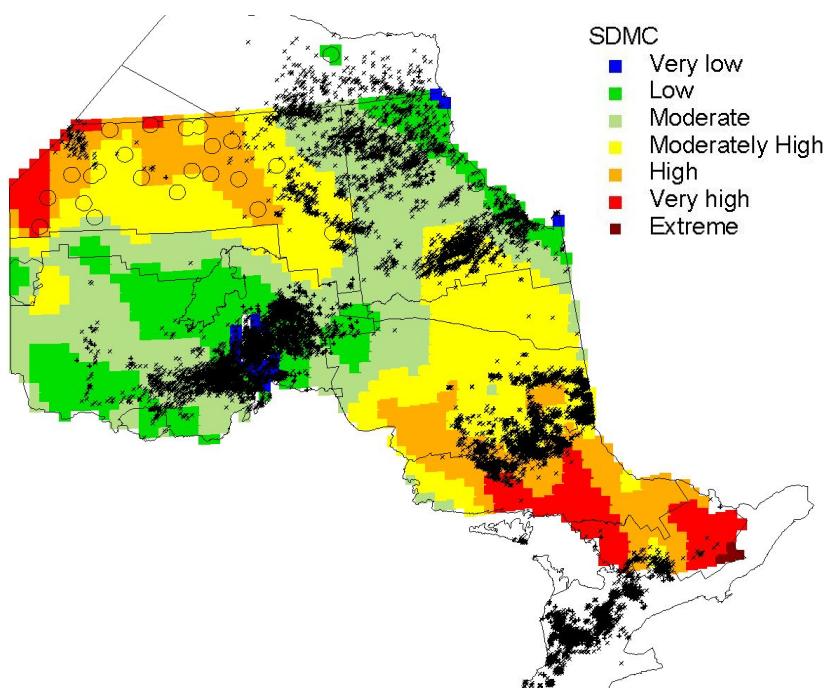


July 21, 2001



July 21, 2001



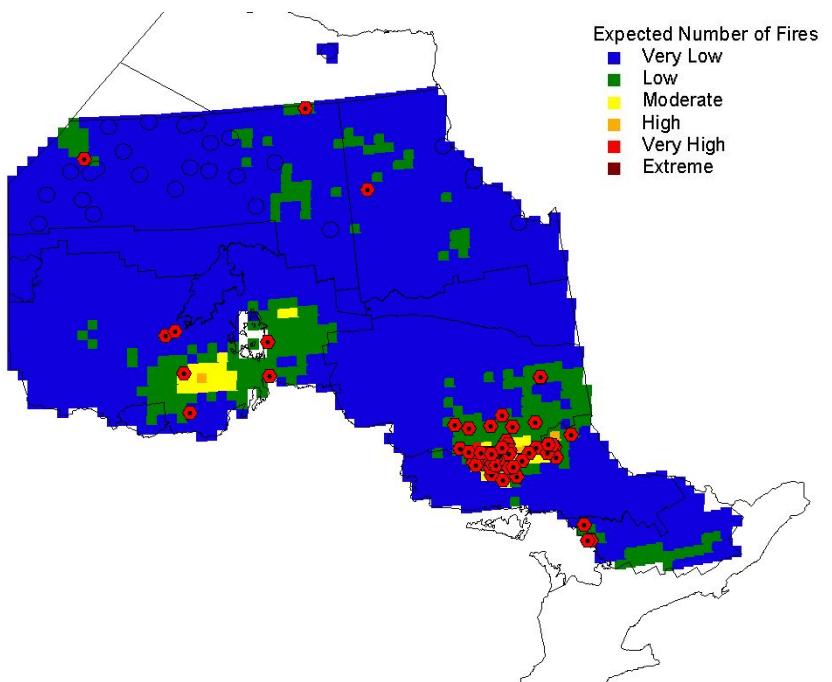


July 21, 2001

Sustainable Ignitions

Observed = 52

Predicted = 31 to 52

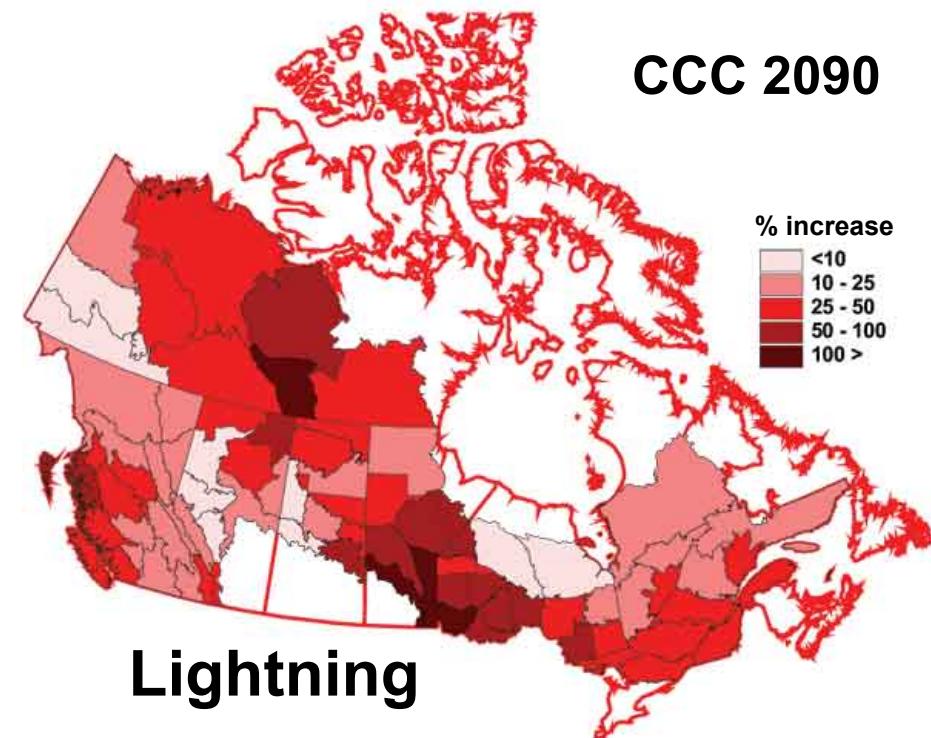


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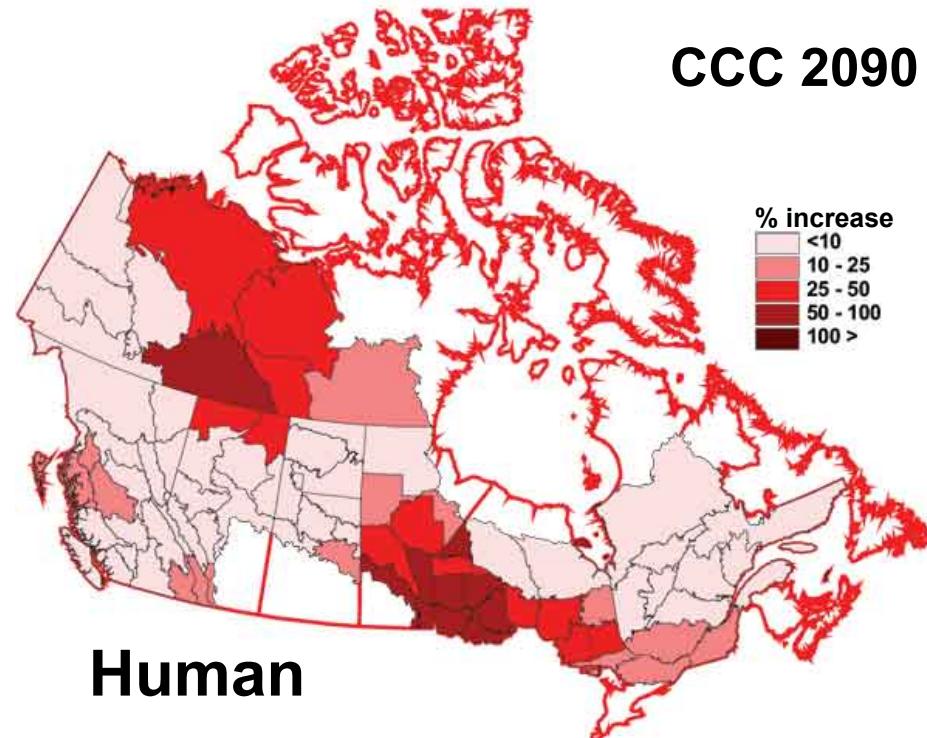
Fire & CC impacts: fire occurrence

**Changes from current levels in number of lightning
and human-caused fires**



CCC 2090

Lightning

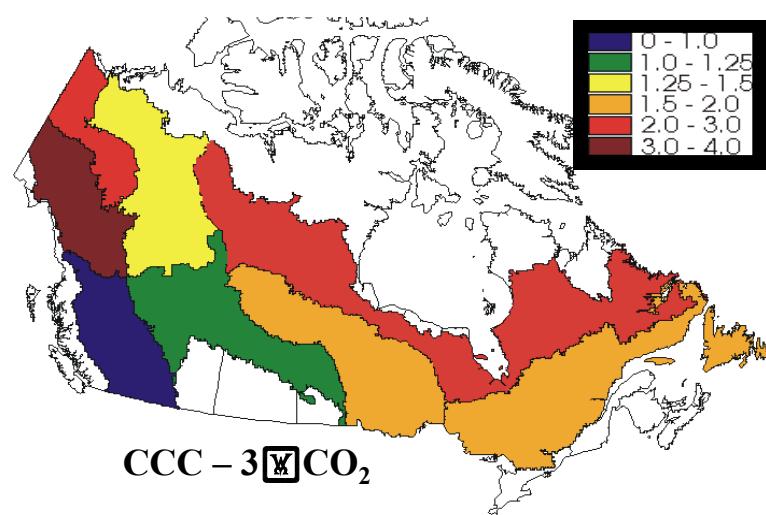


CCC 2090

Human

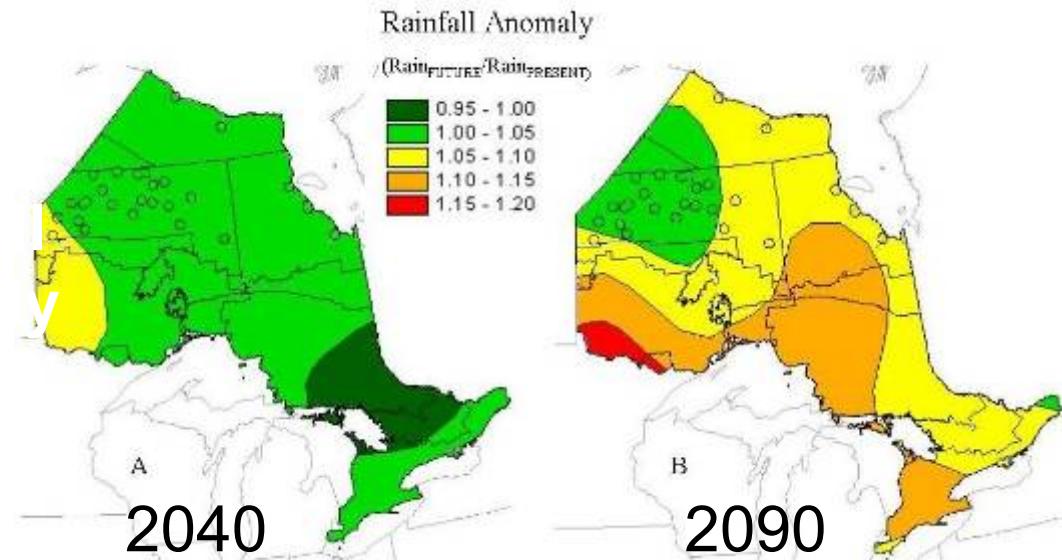
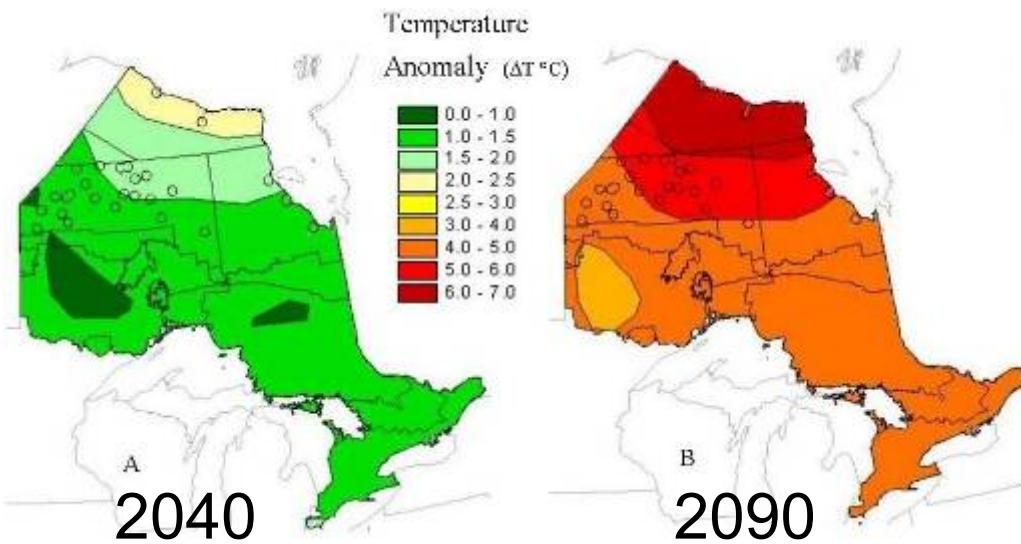
Fire & CC impacts: Area Burned

- Overall, increases were about 75 % by 2090.
 - Considerable regional variation
 - Mountains not well resolved in the GCM
- Other recent studies have shown greater increases



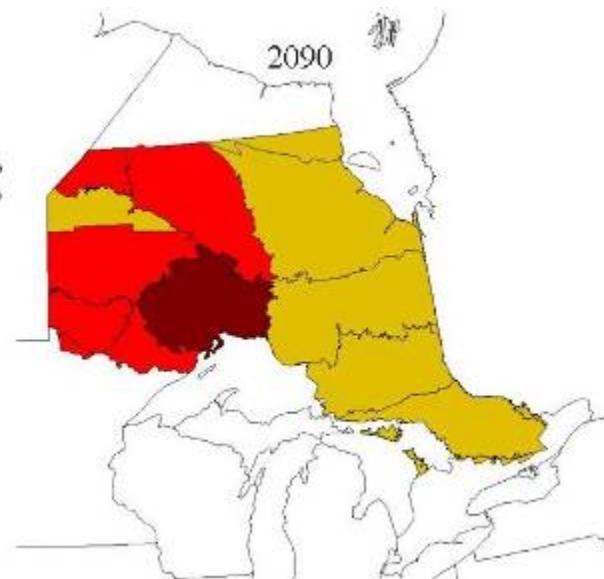
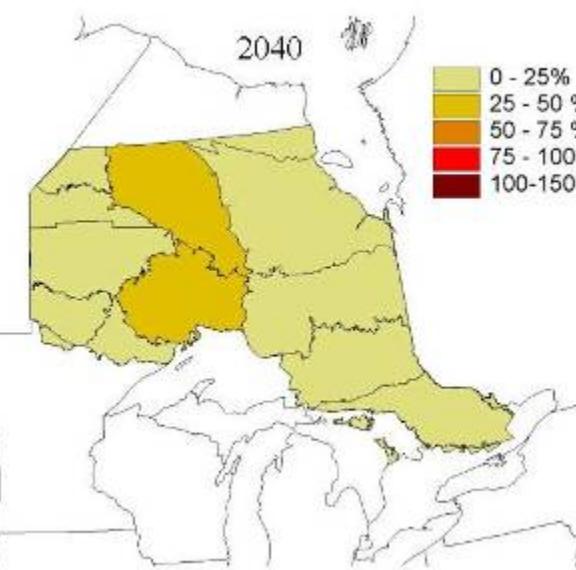
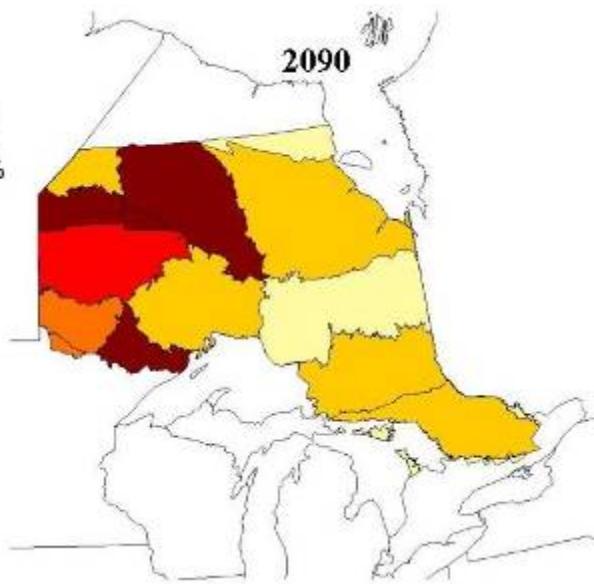
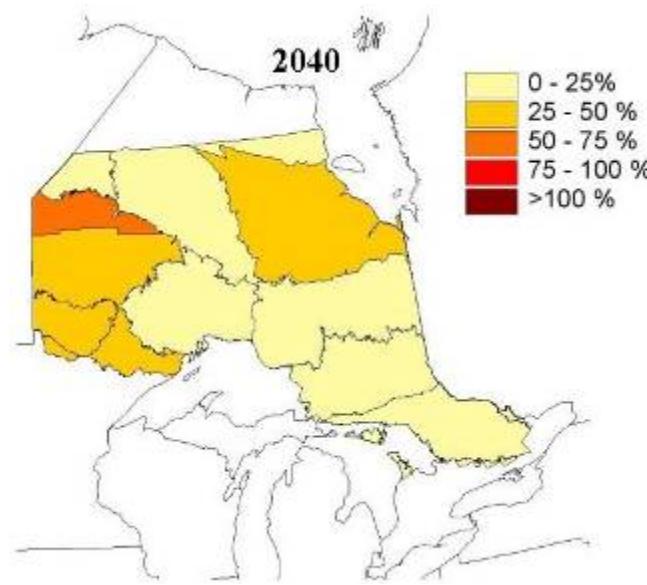
Flannigan et al. 2005: Climatic Change

Fire & CC impacts: Fire Management



Fire & CC impacts: Fire Management

Human
caused
fires



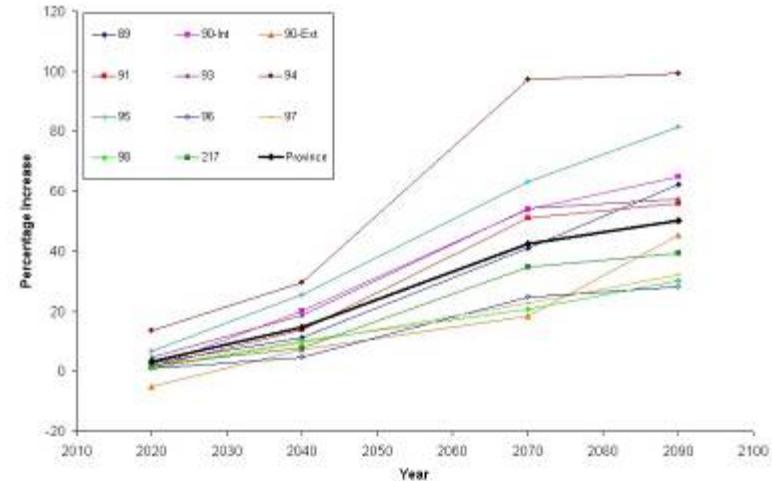
Lightning
caused
fires

Fire & CC impacts: Fire Management

- Fires
 - 2040 : 15%
 - 2090: 50%

Results from LEOPARDS

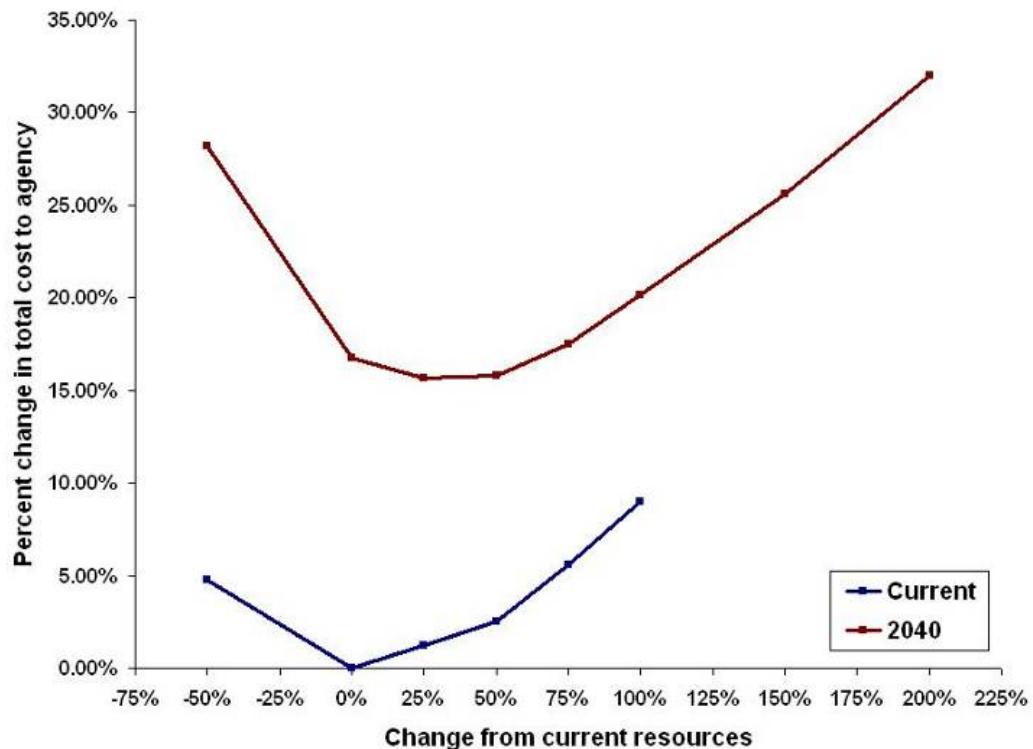
- Escapes
 - 2040 : 36%
 - 2090 : 85%
- AB
 - 2040: 31%
 - 2090 : 77%
- Costs:
 - 2040: 16%
 - 2090 : 54%



All changes are current
baseline values

Fire & CC impacts: Fire Management

- Adapation??
 - Increase resource levels (more tankers, helicopters, crews)
 - Examine the changes in costs to the agency
 - Operating costs + basic losses due to area burned
 -



Fire & CC impacts: Fire Management

